2½ inches per hour, which enables the time of an event to be measured to within from fifteen to thirty seconds. That the instrument is sufficiently sensitive and reliable is shown by the fact that except when being tested no record has thus far been obtained except for real earthquakes.

The instrument is a modification of a form devised by the writer early in 1885, as is shown in Fig. 1.

*W* is a heavy lead weight, shown partly in section, and is suspended on a short steel link, *A*. The weight is pivoted to this link by means of the sharp pointed screw, *b*, the point being just above the center of gravity of the weight, so that the latter will balance and remain stable on the pointed support. A similar pointed support, *f*, is provided for the top of the link, which hangs from a small projection from the frame of the instrument, *B*. The pin, *f*, is extended upward from the link, being in all about 6 inches long, and is made slender and flexible. At the top the needle-like prolongation of the link, *A*, is tipped with platinum, and passes loosely through a small hole in the plate, marked *C*. The hole in the plate is bushed with platinum; four screws, two of which, *S*, *S*, are shown, enable one to adjust the position of the plate, so that the platinum-tipped needle will pass through the center of the hole and not touch it on any side. The plate, *C*, is electrically insulated from the rest of the instrument, but connected with a wire to a binding post on the base.

The action of the instrument is easily understood. Any movement of the base or frame of the instrument affects the point from which the link, *A*, is suspended. The heavy weight, *W*, does not partake of this motion, but tends to remain at rest; the result is that the link is displaced from the vertical a little, and the motion is greatly magnified at the top end of the long needle-like extension. Supposing the needle to be originally set so as not to touch the sides of the hole in the plate, *C*, it is plain that a disturbance will cause it to repeatedly strike the sides of the hole, and, when the instrument is appropriately connected with batteries and electrical apparatus, the contact of the needle with the sides of the hole can be made to stop a clock or to produce an automatic record on a sheet of paper.

The register used with the Weather Bureau seismograph is simply a so-called weekly anemometer register, and is shown in Fig. 2.

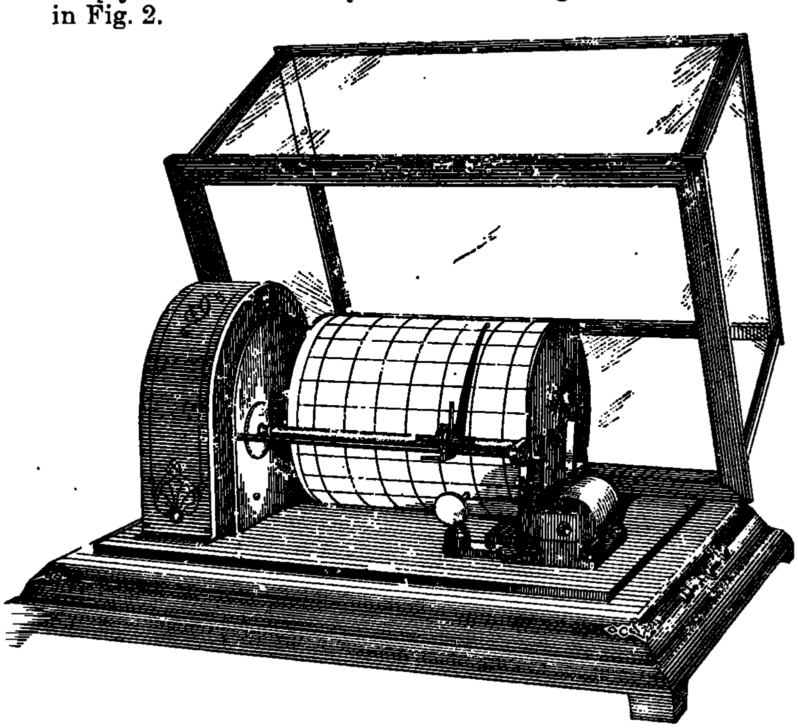

FIG. 2.—Weekly anemometer register.

The cylinder of this register revolves once in six hours, and the pen is so controlled as to trace a spiral line on the sheet which receives the record for seven days without changing. The electro-magnet seen on the base of the instrument is connected with the seismograph, and whenever the circuit is closed the pen makes a jog or offset in the line traced. The sheet of paper is marked off with hour lines and finer spaces of five minutes each, so that the time of any event marked by the offsets in the trace made by the pen can be accurately measured. A minute of time is represented by a space of one twenty-fourth of an inch on the sheet. As the clock which drives the cylinder can not be depended upon to keep time accurately, the electro-magnet is also connected with a good pendulum clock fitted with a device which momentarily closes the circuit at intervals of exactly five minutes to the nearest second. Finally, the error of the pendulum clock is obtained and recorded almost daily from the telegraphic time signals sent out by the Naval Observatory.

The record of an earthquake consists of a succession, more or less prolonged, of lateral jogs or strokes on the line traced by the pen, whereas the clock record consists of a single stroke occurring regularly and of very short duration.

The apparatus thus described requires very little attention to maintain in operation. The time scale of the record is greatly condensed, but less than half a minute of time can be discerned.

The seismograph is mounted on a stone slab cemented to the floor of the basement of the Weather Bureau building. It does not appear to be disturbed by the ordinary tremors due to artificial causes.

## TORNADOES AT CHERRY HILL, N. J., AND WOODHAVEN, LONG ISLAND, N. Y.

Text by Mr. E. H. EMERY; photographs* by Mr. H. GOUCHER, Assistants at the Weather Bureau station, New York, N. Y.; dated August 21, 1895.

In the afternoon of July 13, 1895, there occurred in northeastern New Jersey, western end of Manhattan Island, and western portion of Long Island a series of atmospheric disturbances, partaking of the nature of severe wind and hail storms in some places, and in others of tornadic movements. From Atlantic Highlands to Cape May thunderstorms, with hail and high winds, prevailed, damaging crops and fruit trees. At Cherry Hill, N. J., and Woodhaven, L. I., the storms were tornadic in their chief phases and usual effects. Cherry Hill is distant north of Hackensack, N. J., 1½ miles, and northwest of Harlem, N. Y., 11 miles. Harlem is 11½ miles northwest of Woodhaven. The path of the storm was in a southeasterly direction, passing over Harlem, N. Y., thence to Woodhaven. [Woodhaven is about 8 miles east-northeast of the Weather Bureau station in New York City.]

At Cherry Hill the storm commenced its destructive work. Four dwellings and a depot were destroyed and 26 other buildings partly shattered. Amount of damage estimated at $50,000. Three persons were killed. About 3.30 p. m. black clouds were observed coming from the northwest; it was 3.45 p. m. when the storm broke out, and five minutes later came the destructive wind.

At nearly the same time that buildings were being blown down at Cherry Hill a severe wind and hail storm was raging in that portion of New York called Harlem, between One hundred and twenty-fifth street and Woodlawn Cemetery, East River and Kings Bridge, continuing for twenty minutes. Here the storm had nothing of the tornado about it. From this point the disturbance passed on to one of the suburbs of Brooklyn, which is southeast of Harlem. The destruction by violent winds began at Cypress Hills Cemetery. As observed by an eye witness, there seemed to be a meeting of two large black masses of clouds, one coming from the north-

*The photographs are not reproduced.

west the other from the southwest. After coming together, the movement of the whole mass was toward the southeast. The color of the under mass of clouds was of a dirty brown. Darkness came on, and with it gusts of wind. A whirring noise was heard. The trees in the cemetery were observed to go down as the cloudy mass approached. The storm emerged from the cemetery with "a roar" and a funnel-shaped cloud with a twisting movement. After leaving Cypress Hills, the storm followed a varying course along Jamaica avenue to Enfield street, thence parallel with Rockaway road to Woodhaven.

Considerable damage was done to trees and telegraph poles on Jamaica avenue and Enfield street. Ten dwellings on Rockaway road were injured, eight on Second street, and three in University place; in addition to these, the brick schoolhouse was partially destroyed. Union Race Course, which is north of the railroad track, suffered badly, but not so much as the district south of the track. The funnel-shaped cloud, in its passage to the southeast, was observed to rise and fall at intervals; when high above the houses little or no damage was done, but when it came nearer to the earth, buildings in the path sustained the most injury. After leaving Woodhaven, the tornado took a southerly course, decreasing in violence, and passed out over Jamaica Bay, where the waters were observed to be greatly disturbed.

The length of path of storm, where evidences of the tornado are to be seen, is three-fourths of a mile; the width of greatest destruction is 300 yards, while that of partial destruction is 650 yards.

After the storm a personal inspection of a corn field and several tomato patches showed a very nice distribution of the stalks and plants, as follows: On the southwest side of the path of the storm, they were all lying with their tops toward the east and northeast with notable regularity, while on the northeast side the tops were toward the southwest and west. Similar observations were extended to the scattered timbers of buildings; in many places the same order of arrangement was apparent.

At Woodhaven one person was killed. The investigating committee at Woodhaven has placed the amount of damage to buildings at $25,000. These figures do not include the injury done to the schoolhouse, which will amount to $18,000.

The atmospheric conditions observed at New York station during the afternoon of July 13, 1895, and reduced to sea level, are here given:

| 75th meridian time. | Pressure. | Temperature. | Time. | Wind direction. | Velocity. |
|---|---|---|---|---|---|
| | *Inches.* | ° | | | *Miles.* |
| 1 p.m. | 29.64 | 70 | From 1 to 2 p.m. | S. | 9 |
| 2 p.m. | 29.63 | 73 | 2 to 3 p.m. | S. | 12 |
| 3 p.m. | 29.60 | 72 | 3 to 4 p.m. | S. and SW. | 12 |
| 4 p.m. | 29.60 | 73 | 4 to 5 p.m. | N. | 13 |
| 5 p.m. | 29.61 | 70 | 5 to 6 p.m. | E. | 8 |
| 6 p.m. | 29.62 | 71 | | | |

A squall struck the New York station shortly after 3 o'clock, with light rain from 3.18 p. m. to 3.23 p. m., and a maximum velocity of 26 miles.

## ATMOSPHERIC TEMPERATURES DURING THE MONTH OF JULY.

By W. F. R. PHILLIPS, M. D., U. S. Weather Bureau.

Atmospheric temperature is well recognized as an important element of climate in general and climates in particular.

The fact that two or more places may have the same mean temperature, either annual, monthly, or daily, does not, of necessity, imply identical thermal conditions. An example will illustrate this fact more forcibly than an elaborate theoretical explanation. Thus, Des Moines, Iowa, and Tatoosh Island, Wash., have the same annual mean temperature, namely, 49°. But the mean temperature of the hottest month at Des Moines is 75°, and at Tatoosh Island 56°. The mean temperature of the coldest month is 18° at Des Moines, and 41° at Tatoosh Island. The highest temperature recorded at Des Moines is 104°, at Tatoosh Island 78°, and the lowest temperature 30° below zero at Des Moines and 7° above at Tatoosh Island. The total range is 134° for the former and 85° for the latter.

Thus it is seen that for a correct apprehension of the thermal conditions of different places, even though on the same isotherm, it is necessary to consider the various phases of atmospheric temperature.

These phases will be taken up in the order following:

1. The mean daily temperature, or the average degree of heat experienced in twenty-four hours; which, meteorologically defined, is the arithmetical mean of twenty-four hourly observations; but which, in practice, is found to be sufficiently accurate and more easily obtained by using the mean of the highest and lowest temperatures recorded by self-registering thermometers.

2. The mean maximum temperature, or the average of a series of the highest daily temperatures recorded during a given time.

3. The mean minimum temperature, or the average of a series of the lowest daily temperatures recorded during a given time.

4. The mean daily range of temperature, or the difference between the mean maximum and the mean minimum.

5. The mean daily variability of the temperature, or the average difference between the temperatures of any two consecutive days.

6. The absolute maximum temperature, or greatest degree of heat experienced at any moment during a given time.

7. The absolute minimum temperature, or the lowest degree of heat experienced at any moment during a given time.

8. The absolute range of temperature or the difference between the absolute maximum and minimum.

The first five phases show the temperature probabilities, and the last three the temperature possibilities of a climate. In addition to these statistics of temperature, it is desirable that we should possess information as to the frequency of spells of several consecutive days of either very hot or very cold weather; but to obtain this information it is first essential that we settle upon what shall be regarded as the minimum limit of an excessive departure from average conditions. This is not by any means an easy matter to determine, as an instance will show. At Galveston, Tex., only four times in 15 years has the mean daily temperature in July been 4° above the normal for the month—for that period, 84°. At St. Louis, Mo., in the same years there have occurred 18 days having mean temperatures of 10° or more above the normal, 79°, or more than twice the excess at Galveston. If only the numerical values of the departures from the normals be used as the standard of comparison, Galveston, when compared with St. Louis, would appear never to suffer from periods of abnormally excessive heat; but we find that while in 15 years on sixteen occasions a mean daily temperature of 87° has been maintained for three or more consecutive days at St. Louis, yet, during the same period on twenty-three occasions, a mean of 86.3° has been maintained for three or more days at Galveston. The average duration of these periods has been 6.8 days at Galveston, and 5.6 days at St. Louis.

The question as to the possible physiologic effects of such temperatures, as well as the determination of the limits that shall constitute excessive departures, are features worthy of future study and consideration.

The subject to which this article particularly relates is the distribution of temperature over the United States during the month of July. This month has been chosen, because, first,